

# Examining Online Platforms of STEM Centres for Upping Outdoor STEM Education in Latvia

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**Abstract**—For addressing the issue of regional inequalities in access to STEM education, the STEM centres are located in Riga, the capital city of Latvia, as well as other cities, namely Cesis, Liepaja, Sigulda, and Ventspils, established in different regions of Latvia. A visit to a STEM centre in Latvia starts with the investigation of its online platform. The aim of this work is to build a framework for the analysis of online platforms of STEM centres in Latvia. The guiding research questions is: What are functions and sub-functions of online platform of the STEM centre? The descriptive study is employed in this work. The study is aimed at identification of functions and sub-functions of online platforms belonging to STEM centres. In the digital age, online platforms ensure links between STEM centres and their visitors. Online platforms of STEM centres provide important information about STEM centre's aims, functions, facilities, and services. Online platforms also serve as a communication tool (use of emails and similar) between the STEM centre and its clients as well as stakeholders. The theoretical analysis allows shaping the framework for analysis of online platforms belonging to STEM centres. The framework is built of key functions (organisation contact information, educational programmes, and training to services) and sub-functions that online platforms are expected to present. The comparative analysis based on the descriptive study shows that only two online platforms provide the information about all the sub-functions highlighted in the developed framework. Two platforms mostly disclose the sub-functions, and one platform partly covers the necessary information. It should be noted that four

STEM centres that fully or mostly reveal the sub-functions have been supported by Norway grants or belong to Riga Technical University. Our theoretical analysis is limited by the number of existing scientific literature in English. Theoretical analysis in other languages than English may advance further development of online platform for strengthening of STEM education. Another limiting factor is that online platforms were observed by the researchers who took part in this study. Interviews or surveys with the participation of online platforms' users might lead to the creation of a framework with other key functions and subfunctions. Practical implications on a design of online platforms for STEM centres imply that online platforms should be user friendly. Another important aspect is to include all the organisations details such as name, a short description (year of establishment, staff number, etc), address and email, phone number, social media, and location on the map. In regard to educational materials, important is to give open access to the educational materials to all the users. This might increase their interest to visit STEM Centre in person. Another practical implication is to unite the five STEM centres in Latvia in one network and to establish close collaboration between them. This collaboration would support the whole approach to outdoor STEM education, the development of systemic, sequential, and gradual educational materials. This would increase learners' understanding of STEM education as well as sustainable development of Latvia. The links between five STEM centres in Latvia should also be shown on their online platforms.

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**Keywords—***Science Technology Engineering Mathematics (STEM), STEM centres, online platforms, outdoor STEM education.*

## I. INTRODUCTION

In 2027, the labour market in Latvia will lack approximately 14,000 specialists in STEM (Science, technology, engineering and mathematics) fields [2]. However, the supply of STEM-related skills in the Nordic – Baltic region suggests that in this regard Latvia performs the worst in terms of both recent university graduates and working-age population in general [9]. Only about 24% of students choose STEM subjects [1] to study at university level. Therefore, Latvia is facing a challenge of attracting more potential students to study STEM in higher education. This is one side of the problem in STEM education.

Another aspect of the lack of STEM students is that the interest of prospective students to STEM subjects has to be cultivated before the moment when young people are confronted with the choice of a higher education discipline to be studied. Latvia is addressing this issue by establishing STEM centres in different cities of Latvia, e.g. Cesis, Liepaja, Ventspils, Riga, and Sigulda. These five STEM centres are targeted to different age groups: from pre-primary school children to adult education learners.

One more issue with STEM subjects is that some of the STEM disciplines require natural environment. For example, biodiversity observation, or analysis of geographical peculiarities, or birds' watching, or water check, or similar. Outdoor STEM education is beneficial for learners of all ages as it gives freedom to explore, and motivation to learn by becoming more confident [3], [4]. Learners become more involved in STEM education [3], [4]. Learning in the outdoor environment enriches learners' self-discovery process and supplements his or her experience with emotions [14] that are a driving engine in learning and education [16]. In addition to academic knowledge, the outdoors can foster curiosity, communication, social skills and personal experience [14]. For providing a diversity of natural environments, STEM centres were created in three different parts of Latvia, namely Cesis, Liepaja, and Ventspils. These three STEM centres in Cesis, Liepaja, and Ventspils offer outdoor activities in three different natural environments. STEM centre in Cesis offers observation of natural resources, in Liepaja - water and relevant nature, in Riga – wind and geographical landscape for drones and aviation, in Ventspils - healthy lifestyle, human and self-exploration, and geography.

Another aspect of the STEM education is that use of rich geodata and administrative data on Latvia show that 43 percent of youth aged 15 to 18 cannot reach a STEM program within 30 minutes by walking [9]. Estimates of earnings differentials by access time, between program types, and between two modes of travel suggest that children from wealthier families have better access to STEM programs [9]. More densely populated settlements feature better access to STEM programs, as well as better exam results in STEM disciplines [9].

For addressing the issue of regional inequalities in access to STEM education, the STEM centres are located in Riga, the capital city of Latvia, as well as other cities, namely Cesis, Liepaja, Sigulda, and Ventspils, established in different regions of Latvia. A visit to a STEM centre in Latvia starts with the investigation of its online platform.

The aim of this work is to build a framework for the analysis of online platforms of STEM centres in Latvia. The present research intends to provide practical implications on a design of online platforms for STEM centres.

## II. MATERIALS AND METHODS

The guiding research questions is: What are functions and sub-functions of online platform of the STEM centre?

The descriptive study is employed in this work. The study is aimed at identification of functions and sub-functions of online platforms belonging to STEM centres.

The descriptive study starts with the analysis of existing theoretical frameworks for online platforms design. Afterwards, five online platforms belonging to existing STEM centres in Latvia will be described. The description of these five online platforms will be based on researchers' interpretation of the available information on these online platforms [6]. It should be highlighted that both versions of online platforms, namely Latvian and English, were analysed. First, the English version of the platform was observed, and, in case of the lack of information, the Latvian version was addressed. The next step of our study will be the comparison of the descriptions of five online platforms. Finally, practical implication on a design of an online platform belonging to STEM centres will be proposed.

## III. RESULTS AND DISCUSSION

### A. Building a Framework for Analysis

The research devoted to the analysis of online platforms of STEM centres is scarce.

Due to the lacuna in research on online platforms of STEM centres, the study is based on the authors' assumption that online platforms reflect the performance of STEM centres.

It is worth highlighting that STEM centres in Latvia refer to non-formal STEM education. Non-formal education means any organised educational activity outside the established formal system - whether operating separately or as an important feature of some broader activity - that is intended to serve identifiable learning clientele and learning objectives (Coombs, Prosser & Ahmed, 1973). Non-formal education aims to create empowerment opportunities for learners [12].

Hence, building a framework for analysis of online platforms starts from the review of models leveraged for the organisation of STEM centres' work. Our search for model of the organisation of STEM centres' work revealed only two scientific publications. In both publications [11], [10], functions of STEM centres are defined as

- Educational programmes and training;
- Services (networking, infrastructure, resources); and
- Educational research.

It should be noted that online platforms belonging to STEM centres are different from online platforms designed as learning platforms [7]. The difference exists in that learning platforms have such functions as learning analytics, provision of open badges as micro-credentials, and similar [8].

Theoretical analysis of functions of STEM centres as well as observation of online platforms carried out by the authors allow shaping the framework modelling the functions and structure of online platforms belonging to STEM centres.



Fig.1. Framework for analysis of online platforms of STEM centres.

The logics of the framework is based on the analysis of existing research and educational interest of the researchers taking part in this work: from organisation contact information through educational programmes and training to services.

### B. Analysis of Online Platforms

#### B1. STEM Centre in Cesis

Table 1 presents the description of the online platform belonging to STEM Centre in Cesis, Latvia [17].

TABLE 1 ANALYSIS OF ONLINE PLATFORM OF STEM CENTRE IN CESIS

Key function	STEM Centre in Cesis		
	Sub-function	Yes/No	Comment
Organization contact information	Name	Yes	Space Educational Centre
	Description (year of establishment, staff number, etc)	Yes	- Staff photo and relevant emails are shown, - Video presentations
	Address and email	Yes	
	Phone number	Yes	With international code +371
	Social media	Yes	

Key function	STEM Centre in Cesis		
	Sub-function	Yes/No	Comment
Educational programmes and training	Location on the map	No	
	For learners (with age group and educational level)	Yes	For schools
Services	For trainers	Yes	Including for organizations
	Vision, mission, and aim	Yes	To promote children interest
	Visit information	Yes	
	Events	Yes	Including workshops for children, birthday parties

The observation of the online platform reveals that the platform is designed with the use of features conventionally related to the space area, e.g name of the café “Orbita”, a darker colour of the platform associated with the colour of space, the symbol of “rocket” as a mouse indicator, and similar elements.

The platform offers the description of 3 non-formal educational programmes:

- "Living in Space" (4th-6th grade): The purpose of the workshop included in the program is to find out where the Earth is in the universe, what technologies are needed so that we can go to other planets
- "Space Ascension" (classes 7-9): The purpose of the workshop included in the program is to prepare and launch a rocket, using microcontrollers to calculate all the necessary information.
- "Landing on an unknown planet" (classes 10-12): The purpose of the workshop included in the program is to calculate, test and create a system designed to save people on another planet. To do this will require microcontroller programming and testing for data acquisition.

Educational programmes for school children are well structured in accordance with the children age and educational level and described. Exemplary educational materials with open access are available on the platform. The material, activities, resources are described in a good and simple way. Instructions for teachers are available as well. However, learning outcomes could be described, too.

For elementary school teachers, the platform provides the description of the educational programme, namely Education program for professional development of teachers: "Creating a successful interdisciplinary connection between STEM and humanitarian subjects".

For organizations, the Centre offers the simulation "Auseklis" for the development of organizations' staff skills in communication and cooperation.

The Space Educational Centre is an educational leisure and extracurricular destination that offers exploratory experiences for families and school groups. Combining education, hands-on lessons and a popular science approach with a space theme.

The main goal is

- to encourage children's interest in the field of science, technology, engineering and mathematics,
- to offer them a view through the prism of space, and
- to encourage them to connect their future with it.

Interactive exposition of the Centre allows visitor to develop their skills in space exploration, living outside the Earth, physical and mental health of an astronaut, etc.

The STEM centre in Cesis is established with the support of Norway grants.

### B2. STEM Centre in Liepaja

Table 2 gives the description of the online platform belonging to STEM Centre in Liepaja, Latvia [18].

TABLE 2 ANALYSIS OF ONLINE PLATFORM OF STEM CENTRE IN LIEPAJA

Key function	STEM Centre in Liepaja		
	Sub-function	Yes/No	Comment
Organization contact information	Name	Yes	Science and Education Innovation Center /ZIIC
	Description (year of establishment, staff number, etc)	Yes	- Staff photo and contact details are shown, -Historical overview is presented
	Address and email	Yes	
	Phone number	Yes	Without international code +371
	Social media	Yes	
	Location on the map	Yes	The Centre has three different locations
Educational programmes and training	For learners (with age group and educational level)	Yes	For schools
	For trainers	Yes	
Services	Vision, mission, and aim	Yes	To arouse children interest
	Visit information	Yes	

Key function	STEM Centre in Liepaja		
	Sub-function	Yes/No	Comment
	Events	Yes	Including workshops for children, birthday parties

The observation of the online platform discloses that the information and the STEM Centre is well structured.

The Centre presents the description of two non-formal educational programmes for children:

- Environmental management for children aged 5 to 10 years,
- Environmental management for children aged 11 to 18.

The educational programmes for children are supported with video materials. Methodical materials with instructions for teachers as well as illustrations are given.

Description of two training programmes for teachers is also shown:

- Ecotechnology for improving the learning process,
- Digital production in education.

However, the detailed description of these two educational programmes for teachers is not available.

The Science and Education Innovation Center offers interactive exhibits. Visitors can try out different technologies and test the laws of nature for themselves. The aim of ZIIC is to use the existing expositions at ZIIC to arouse interest, look for answers, understand them and enjoy the pleasure of cognition.

This STEM Centre has three different facilities in different locations in Liepaja: author street, nature house, and FabLab, co-creation place.

The exposition of the Nature house includes laboratory equipment, models, and laboratory equipment.

The Nature House fosters the skills in becoming bird researcher, quality of water specialist, young geographer, young eco-technologist, young botanist, ant researcher, and protected nature areas.

The STEM centre in Liepaja is established with the support of Norway grants.

### B3. STEM Centre in Riga

Table 3 introduces the description of the online platform belonging to STEM Centre in Riga, Latvia [19].

TABLE 3 ANALYSIS OF ONLINE PLATFORM OF STEM CENTRE IN RIGA

Key function	STEM Centre in Riga		
	Sub-function	Yes/No	Comment
Organization contact information	Name	Yes	FUTURIMO
	Description (year of establishment, staff number, etc)	Yes	Staff photo

Key function	STEM Centre in Riga		
	Sub-function	Yes/No	Comment
	Address and email	Yes	
	Phone number	Yes	With international code +371
	Social media	Yes	
	Location on the map	Yes	
	For learners (with age group and educational level)	Yes	For schools
Educational programmes and training	For trainers	No	
	Vision, mission, and aim	Yes	To stimulate children interest
Services	Visit information	Yes	
	Events	Yes	Including boot camps

The observation of the online platform allows finding that the presented information is well organised.

The platform proposes the description of five non-formal educational programmes:

- Little Engineers: Can Newton's Third Law be explained and taught to preschoolers? It can be taught through playing and practical activities with everyday objects, age-appropriate toys and objects around us in nature.
- Engineering Club: A series of practical lessons for high school students, in which they will acquire the skills to independently conduct research in the STEM field, learning physics, electronics, robotics and prototyping.
- Electronics Workshop: A practical cycle of lessons for students, in which they will learn the basics of electrical engineering. They will get an idea of the elements of electrical engineering and electronics, their operation, learn to use various instruments, measuring devices and equipment, solve and analyze electrical engineering problems, evaluate the energy efficiency of equipment, as well as design and develop prototypes.
- Piloting of Unmanned Aircraft (Drones): Nowadays, drones are used very widely - from toys for entertainment to capturing various events in photos and videos, surveying territories and objects, ensuring protection, etc. Even sports competitions are held, where drones reach a speed of 250 km in flight.
- Basics of Aviation Technology: A unique group for aviation enthusiasts, where you can not only gain knowledge about aircraft, their structure, history and achievements, but also try your hand at piloting aircraft using simulators and see with your own eyes the

daily operation of airports by visiting Riga Airport and the training centre of the national airline "airBaltic".

Instructions for teachers as well as textbooks, video materials, and illustration are not available.

The platform does not offer any educational programme for teachers.

The aim of the Centre is to stimulate children's interest in engineering, giving them the opportunity to associate their future profession with it.

The STEM Centre is part of Riga Technical University from Latvia.

#### B4. STEM Centre in Sigulda

Table 4 highlights the description of the online platform belonging to STEAM Centre in Sigulda, Latvia [20].

TABLE 4 ANALYSIS OF ONLINE PLATFORM OF STEM CENTRE IN SIGULDA

Key function	STEM Centre in Sigulda		
	Sub-function	Yes/No	Comment
Organization contact information	Name	Yes	STEAM Centrs
	Description (year of establishment, staff number, etc)	Yes	Staff information and photo
	Address and email	Yes	The address is not given
	Phone number	Yes	With international code +371
	Social media	Yes	
	Location on the map	No	
Educational programmes and training	For learners (with age group and educational level)	Yes	School children including family members
	For trainers	Yes	
Services	Vision, mission, and aim	Yes	To develop learners' skills
	Visit information	Yes	
	Events	Yes	Including Workshops at schools and educational parties

The online platform is available only in Latvian language.

The online platform offers educational programmes for school children, families and teachers /trainers. However, details about the educational programmes are not revealed.

The STEAM (Science, Technology, Engineering, Art and Mathematics) centre aims at developing students' creativity, critical thinking and problem-solving skills though an innovative and practical approach to learning. It

gives access to modern teaching tools and technologies (virtual reality, fable robots, fun floor, and korbo blocks) for the development of real projects. The centre is a place where students can experiment, collaborate and delve into various topics, from robotics and programming to combining art and design with technology to make a step into the global age of innovation. The STEAM Centre is part of Roboschool.

*B5. STEM Centre in Ventspils*

Table 5 discloses the description of the online platform belonging to STEM Centre in Ventspils, Latvia [21].

TABLE 5 ANALYSIS OF ONLINE PLATFORM OF STEM CENTRE IN VENTSPILS

Key function	STEM Centre in Ventspils		
	Sub-function	Yes/No	Comment
Organization contact information	Name	Yes	Science Centre VIZIUM
	Description (year of establishment, staff number, etc)	No	
	Address and email	Yes	
	Phone number	Yes	With international code +371
	Social media	Yes	
	Location on the map	No	
Educational programmes and training	For learners (with age group and educational level)	No	
	For trainers	No	
Services	Vision, mission, and aim	Yes	To educate children
	Visit information	Yes	
	Events	Yes	Creative workshops

The online platform is available in Latvian and English languages.

The online platform does not intend visitors' participation in educational programmes.

VIZIUM represents a future city. The Centre has more than 80 interactive and educational exhibits, including creative workshops and science shows to learn science, physics and mathematics, modern technology and programming, healthy lifestyle, human and self-exploration, geography, etc.

At VIZIUM, everyone can step into the shoes of a football player, shooter and snowboarder, experience the force of earthquake, escape from a virtual maze, try on virtual traditional costumes, go on a roller coaster ride, draw in the virtual reality, etc. VIZIUM also offers visiting technical creative workshops and science shows which provide added value to the visit of the Science Centre.

Pre-school children are given an opportunity to play at the Little Explorers Gallery, where everyone including family members can do shopping at a grocery store and refuel using own game bank card, or to become little constructors and play with water attraction.

The Science Centre VIZIUM also offers to climb the 30-metre high observation platform with the spectacular view over Ventspils.

The mission of the Science Centre is to invite and motivate everyone to be interested in, explore and gain knowledge in STEM field, replenishing the formal education with exciting and interactive world exploring experience.

The STEM centre in Ventspils is established with the support of Norway grants.

Modern learners spend most of their learning lives indoors including use of smart devices [14]. The prevalence of indoor learning in Latvia is often impacted by the weather conditions [15]. The period of the school year (autumn - winter - spring) coincides with the coldest time of the year in Latvia [15]. Due to the weather conditions in Latvia, outdoor activities are mostly used as non-formal education. Outdoor learning is a means of expanding and enriching the educational program through outdoor experiences [14]. The implementation of outdoor education ensures [14]

- sensory experience of learners;
- unity of indoor and outdoor environment;
- awareness of the environment as a whole;
- awareness of the importance of promoting sustainable development;
- identifying the interdisciplinarity of the curriculum.

Based on the factors of cold weather conditions in Latvia and global digitalisation, on the one hand, learners become alienated from the natural environment, and, on the other hand their abilities to work with digital devices increase [14].

In digital age, online platforms ensure links between STEM centres and their visitors. Online platforms of STEM centres provide important information about STEM centre's aims, functions, facilities, and services. Online platforms also serve as a communication tool (use of emails and similar) between the STEM centre and its clients as well as stakeholders. Therefore, for the increase of the online platforms' efficiency, it is important to present all the organisation's details, namely organisations' name, a short description (year of establishment, staff number, etc), address and email, phone number with the international code, social media, and location on the map.

In comparison, the previously implemented research highlighted that effective design of STEM platforms is crucial [22]. This includes the use of terminology on STEM platforms understandable for all users [22]. User friendly design of STEM platforms may help engage different stakeholders such as teachers, learners, researchers, experts, computer specialists, cyber security professionals, industrial representatives [22]. That would be

advantageous for the development of STEM platforms. An important feature of online STEM platforms is that they scale STEM instruction with equivalent learning outcomes at lower cost [23].

Our observation of five online platforms belonging to STEM centres in different regions of Latvia allows finding out that each of the STEM centres has its own specialisation:

- Space Educational Centre in Cesis focuses on space related topics including natural resources;
- Science and Education Innovation Center /ZIIC in Liepaja deals with nature, biology, geography, water;
- FUTURIMO in Riga attracts by wind and geographical landscape for aviation and drones training;
- STEAM in Sigulda has the emphasis on built environment by leveraging virtual reality, fable robots, fun floor, and korbo blocks; and
- Science centre VIZIUM in Ventspils represents healthy lifestyle, human and self-exploration, and geography in a city of the future.

The focus of each STEM centre promotes outdoor STEM education from different perspectives (water, air, earth, space, and nature). Therefore, the cooperation between these STEM centres might strengthen visitors' understanding and skills in sustainable development of Latvia.

#### IV. CONCLUSIONS

The theoretical analysis allows shaping the framework for analysis of online platforms belonging to STEM centres. The framework is built of key functions (organisation contact information, educational programmes, and training to services) and sub-functions reflected in Figure 1 that online platforms are expected to present.

The comparative analysis based on the descriptive study shows that only two online platforms provide the information about all the sub-functions highlighted in the developed framework. Two platforms mostly disclose the sub-functions, and one platform partly covers the necessary information. It should be noted that four STEM centres that fully or mostly reveal the sub-functions have been supported by Norway grants or belong to Riga Technical University.

Our theoretical analysis is limited by the number of existing scientific literature in English. Theoretical analysis in other languages than English may advance further development of online platform for strengthening of STEM education. Another limiting factor is that online platforms were observed by the researchers who took part in this study. Interviews or surveys with the participation of online platforms' users might lead to the creation of a framework with other key functions and sub-functions.

Practical implications on a design of online platforms for STEM centres imply that online platforms should be user friendly. A design of online platform should provide a positive emotional experience to stimulate visitors' curiosity. Another important aspect is to include all the organisations details such as name, a short description (year of establishment, staff number, etc), address and email, phone number with the international code, social media, and location on the map. In regard to educational materials, important is to give open access to the educational materials to all the users. This might increase their interest to visit STEM Centre in person.

Further research will focus on the analysis of experience of online platforms' users. Inclusion of artificial intelligence in online platforms can be studied as well. That might contribute to making online platforms friendly for their users. Comparative studies of online platforms belonging to STEM centres in Latvia and other countries can be helpful for their further advancement. Incorporation of Artificial Intelligence in online platforms of the STEM Centres in Latvia would be an interesting field of investigation. Analysis of scientific literature in other languages than English is an important step in enhancing the framework built within this work.

The research results contribute to the innovation. The innovation is the unity of the five STEM centres in Latvia as one network and the establishment of close collaboration between them. This collaboration would support the whole approach to outdoor STEM education, the development of systemic, sequential, and gradual educational materials. This would increase learners' understanding of STEM education as well as sustainable development of Latvia. The links between five STEM centres in Latvia should also be shown on their online platforms.

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